Restoration

"Restoration uses the past not as a goal but as a reference point for the future. If we seek to re-create [ecological]… communities of centuries past, it is not to turn back the evolutionary clock but to set it ticking again."

—Donald A. Falk
Discovering the Future, Creating the Past: Some Reflections on Restoration

Congress declared the National Park System to be the "cumulative expressions of a single national heritage" because it includes the "superlative natural, historic, and recreation areas in every major region of the United States." Sustaining the diverse and awe-inspiring natural and cultural wonders of this nation for future generations increasingly involves healing the wounds of the past. For this reason, ecological restoration—intensive efforts to recover disturbed natural systems—plays an important and growing role in NPS efforts to fulfill its mission. In 2003, restoration efforts took many forms, from reestablishing natural conditions along a cave tour route and halting unnatural erosion to controlling exotic rats on Anacapa Island and returning the swift fox to the Badlands of South Dakota. In many cases success was enhanced by working with dedicated partners, including corporations, state agencies, and private citizens. Restoration involves a long-term commitment of energy and resources, but as the articles in this chapter make clear, the benefits are priceless.

Since 2000, resource managers of the National Park Service and scientists from the Natural Resource Conservation Service have been working together to restore the Oak Island sandscape at Apostle Islands National Lakeshore, Michigan. They established plots for monitoring in areas where they had heavily planted and where they had tried various techniques to control exotic vegetation.

Restoration of Oak Island sandscape at Apostle Islands National Lakeshore

By Julie Van Stappen

TWENTY-ONE ISLANDS and a strip of mainland set in a matrix of Lake Superior comprise Apostle Islands National Lakeshore in northwestern Wisconsin. The lakeshore is well-known for its diverse, sandy coastal features, known as sandscapes. They include sandspits, cuspate forelands (sandspits that are wider than they are long), tombolos (sandbars that connect two islands or an island and the mainland), a barrier spit, and numerous beaches, which are among the highest quality of any in the Great Lakes region. Sandscapes are very popular visitor-use areas and are among the few places available for boats to access the islands. However, vegetation on sandscapes is very sensitive to trampling.

Park resource managers have been monitoring the lakeshore's 17 significant sandscapes since 1988. Among those monitored is a 1.6-acre (0.7-ha) cuspate foreland on Oak Island that has a long history of human use. Monitoring results over a 10-year period showed that Oak Island housed the most threatened sandscape and required restoration.

"Vegetation on sandscapes is very sensitive to trampling."

Since 2000, park natural resource staff has been working with the Natural Resource Conservation Service's (NRCS) Plant Materials Center in Rose Lake, Michigan, to restore Oak Island's sandscape. Scientists from the NRCS center gathered native plant materials from the site and began propagating 15 species. In 2001 they set up 18 plots for determining appropriate lighting conditions to establish propagated plants, and also collected additional plant materials for restoration. Park maintenance staff assisted with restoration by installing floating boardwalks, which have been very effective in directing visitors and minimizing their impacts on sandscapes.

In late May 2002 the majority of the on-site restoration occurred: a Northland College field ecology class planted 3,200 propagated plants, with NRCS and park staffs providing technical assistance. Follow-up monitoring included establishing 20 plots in 10 of the more heavily planted areas. In addition, park staff set up plots for determining the effectiveness of pulling vs. treating orange hawkweed (*Hieracium aurantiacum*), the most abundant exotic species on the sandscape.

Results of the experimental plots from 2001 showed that plants did equally well in sunny and partially shady conditions. Plants under shady conditions did the best. Plants such as horsetail-like equisetum (*Equisetum arvense*) did extremely well the first year, tapering off during the second year. Plant counts of blueberry (*Vaccinium angustifolium*), rose (*Rosa blanda*), and Pennsylvania sedge (*Carex pensylvanica*) steadily increased with time; common juniper (*Juniperus communis* L.) had a fairly low survival rate (44%) after the first year, but once established did very well.

This cuspate foreland on Oak Island in Apostle Islands National Lakeshore is one of many coastal features comprising the park's 17 significant sandscapes. These lakefront areas are popular with visitors, but are also fragile, easily trampled ecosystems.

Park managers were very encouraged by the results from the 2002 plots: from July 2002 to September 2003, nonnative species decreased from 66% to 41% of the plant count, clearly indicating native species outcompeting nonnative ones. Changes in areal coverage revealed decreases in bare ground and nonnative species and increases in vegetative litter and native species. Results at the plots of orange hawkweed showed that pulling was more effective than chemical treatment.

This restoration effort was challenging. Visitor trampling had removed the thin layer of organic matter that normally provides some protection from extreme conditions, resulting in pure sand, a very harsh environment for new plants. Watering after planting was not feasible because of the difficulty in getting to the site. The only way to get personnel, plants, and supplies to the restoration area was by boat across Lake Superior, and planting needed to be done in spring when storms are frequent. In addition, high visitor use and impacts from deer browsing resulted in less improvement of certain areas after planting.

Lessons learned from the 2003 monitoring results will be applied during restoration efforts in 2004. First, plants propagated from local plant material established successfully and were effective in increasing native plant populations. Second, having a fairly large number of people do the initial plantings was extremely helpful, minimizing the length of time between receiving plants and getting them into the ground. Third, peat pots caused problems by popping up with changing moisture conditions, and the perlite, which is mixed with soil, may have attracted deer. ■

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Positive ecosystem changes on Anacapa Island from rat eradication

By Kate Faulkner, Gregg Howald, and Steve Ortega

THE MOST IMPORTANT step for the restoration of the Anacapa Island ecosystem at Channel Islands National Park, California, was removing black rats (*Rattus rattus*). The exotic rats threatened and preyed upon native species. Beginning in 2001 and continuing the next year, the National Park Service and its partner in the restoration project, Island Conservation and Ecology Group, applied rodenticide to Anacapa Island, as described in *Natural Resource Year in Review—2001* and *2002*. The natural recovery and restoration of the Anacapa ecosystem since eradication have been dramatic, with many rapid, positive changes in native wildlife populations.

A video camera documents a black rat preying on an artificial "bird nest" on Anacapa Island (above, left). Investigators deployed artificial nests, consisting of a brown chicken egg and a plasticine egg, around the island to monitor the presence of rats and to track rates of nest depredation. To mimic Xantus's murrelet nests, investigators placed eggs in rocky crevices, under boulders, and beneath shrubs. They determined the cause of predation by comparing chew marks of known nest predators with marks left on plasticine eggs. Xantus's murrelet eggs that have been found on Anacapa in recent years are few in number and have had large bite marks (top) in the shells that are consistent with rats.

- **Seabirds**
  Within four months of the fall 2002 rodenticide baiting treatment, biologists detected the highest numbers of cavity-nesting seabirds ever recorded successfully breeding on the island. For the first time in decades, rare Xantus's murrelets (*Synthliboramphus hypoleucus*) nested in areas from which rats had previously excluded them. Nesting activity of Xantus's murrelets in 2003, measured using boat-mounted radar, increased by 58% to 200% compared with the prior three years. In addition, two downy Cassin's auklet chicks, a new species for the island, were unexpectedly discovered in what was previously prime rat habitat.

- **Anacapa deer mice**
  Populations of the endemic Anacapa deer mouse (*Peromyscus maniculatus anacapae*) have increased dramatically on east Anacapa, the first of the Anacapa islets from which rats were eradicated in November 2001. Considering that rats had extirpated the native deer mice from east Anacapa, to have the mice present in such high numbers is a spectacular change to that ecosystem. Project staff released wild captive deer mice onto middle and west Anacapa in April 2003 (the spring following the eradication treatment). The mice are reproducing, and population increases are surpassing those measured on east Anacapa the prior year.

- **Birds of prey**
  Birds of prey were at risk of secondary exposure to the rodenticide from preying on or scavenging poisoned rats and nontarget Anacapa deer mice. To avoid exposure, biologists live-captured or translocated as many birds of prey as possible. Currently the diversity and numbers of birds of prey on Anacapa are similar to those before the rat eradication.

The final determination that all rats have been eradicated from Anacapa will not be made until fall 2004 following two years of post-project monitoring. However, the dramatic changes in the ecosystem, coupled with no sign of rats, are early indications of a successful conservation project. Monitoring will continue for a number of years to more fully understand the response of the ecosystem following removal of nonnative rats. ■

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Shoreline restoration at Assateague Island National Seashore

By Betsie Blumberg

RESTORATION OF NORTHERN Assateague Island (Maryland), undertaken to mitigate the effects of a jetty system built in the 1930s to stabilize the adjacent Ocean City Inlet, is proceeding on schedule. The two-phase project, conducted by the U.S. Army Corps of Engineers in partnership with the National Park Service, addresses the long-term effects of the stabilized inlet on the sand supply for Assateague Island. The jetties have prevented the natural movement of sand along the shore from north to south, resulting in unnatural erosion and accelerated island migration. Since the 1930s, portions of northern Assateague have shifted westward more than 325 yards (297 m).

"The objective … is to restore the island's sand budget and ensure that coastal processes continue to dictate the evolution of the island."

The objective of this project is not traditional beach nourishment to protect the shoreline from storm damage or to halt erosion; rather, it is to restore the island's sand budget and ensure that coastal processes continue to dictate the evolution of the island. The transport of sand across the island during storms is a key dynamic influencing both the physical and biological attributes of Assateague Island.

Phase I of the project was the replacement of 1.5 million cubic yards (1.1 million cubic meters) of sand on northern Assateague Island. That operation was completed in 2003. Phase II began at the end of 2003 and will go on for at least the next 25 years: on an annual basis, 150,000 cubic yards (115,000 cubic meters) of sand will be mined in and around the inlet, where it is currently being trapped, and deposited in the surf zone 2 to 3 miles (3.2 to 4.8 km) south of the inlet. This sand will naturally wash up onto Assateague and nourish the island.

The project preserves not only the natural action of the shoreline but also the associated habitat harboring several threatened and endangered species, such as the piping plover (*Charadrius melodus*), sea beach amaranth (*Amaranthus pumilus*), and state-listed endangered tiger beetle (*Cincindella dorsalis media*). A companion long-term monitoring program will evaluate the progress of the project, which may be modified when conditions warrant. ■

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Jetties have prevented the natural north-to-south movement of sand along Assateague Island National Seashore, resulting in unnatural erosion and accelerated island migration. The first phase of a project to restore the island's sand budget and ensure that coastal processes will dictate the island's evolution was completed in 2003. Sand was dredged from a shoal 4 miles (6.4 km) offshore and brought to the Atlantic side of the national seashore by boat where it was pumped as a slurry through a pipeline onto the beach. Bulldozers moved it into place according to the project design. The island has been widened 125 feet (38 m) over a distance of 5 miles (8 km).

Collaboration key to swift fox recovery

By Brian Kenner

ON SEPTEMBER 13, 2003, one more missing piece of the Great Plains ecosystem was returned to Badlands National Park. Wild-born swift fox (*Vulpes velox*), translocated from Colorado, were released into the park. This curious and unwary housecat-sized fox, once common throughout the short- and mixed-grass portions of the Great Plains from Canada to Mexico, had fallen victim to trapping and poisoning targeted at wolves and coyotes.

A radio-collared swift fox pokes its head out of its artificial den in Badlands National Park, South Dakota. After being captured in Colorado and transported to Badlands, the animals were held two weeks in quarantine and then translocated to a suitable release site in the park.

The swift fox is a state-listed threatened species in South Dakota, and its restoration to the Badlands is a result of collaboration among a variety of interests. The Swift Fox Conservation Team (SFCT), an ad hoc group of private, state, federal, and Canadian biologists, was established to further management and restoration of the species. Contacts made with team members at annual meetings proved essential to Badlands' efforts to restore the fox. Also essential to this project is the park's cadre of biologists and technicians funded by the Natural Resource Challenge to restore the black-footed ferret, who have considerable experience in endangered species restoration.

One SFCT member, the Turner Endangered Species Fund (TESF), began a project to return the swift fox to Ted Turner's Bad River Ranches in South Dakota by translocating 30 wild swift fox in 2002 from healthy populations in Wyoming to the ranches. Using the TESF's experience and expertise, Badlands biologists cooperated with scientists from the USGS Northern Prairie Wildlife Research Center and South Dakota State University (part of the Great Plains Cooperative Ecosystem Studies Unit), and obtained funding from the Natural Resource Preservation Program of the USGS Biological Resources Division and the Cooperative Conservation Initiative of the Department of the Interior for a three-year program to capture and release 30 fox per year.

In August 2003, Badlands biologists traveled to Colorado and, with assistance and support from the Colorado Division of Wildlife (another SFCT member), captured 30 swift fox. After a two-week quarantine the animals were released into the park. By December 2003 nine mortalities had occurred. Most of the fox had established themselves in the park and on the surrounding Buffalo Gap National Grassland (the USDA Forest Service is another SFCT member). Large prairie dog complexes and other plentiful rodents and lagomorphs (rabbits and hares) provide the prey base needed for the fox to get established in the area.

Every released fox is radio-collared and will be monitored throughout the year. As the population becomes established and reproduction occurs, park staff will capture and collar the pups to track the population through successive generations. ■

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Interagency implementation of the Comprehensive Everglades Restoration Plan

By Elizabeth Crisfield

In 2000, Congress passed the Comprehensive Everglades Restoration Plan, a $7.8 billion state and federal partnership. The U.S. Army Corps of Engineers and South Florida Water Management District initiated project planning and established interagency working relationships to support implementation of the plan. The South Florida Natural Resources Center coordinates National Park Service involvement in this interagency effort, and a number of additional scientists have been hired in response to the center's new restoration responsibilities.

The plan comprises 68 project components that yield benefits for the natural ecosystem while providing for urban and agricultural uses. The components were described conceptually in the plan authorized by Congress, but each will undergo detailed assessments to select a refined combination of structural features and operations. In 2003, detailed planning started for several components near Everglades and Biscayne National Parks where teams of NPS scientists help evaluate alternatives and select environmentally preferred plans.

Final negotiations on the programmatic regulations, which provide detailed guidance on implementation, also took place in 2003. These regulations, authored by the Corps of Engineers, require Department of Interior and State of Florida concurrence. Environmental organizations pushed for a stronger role for the Department of the Interior in the interagency scientific coordinating body described in the regulations. They also lobbied to have interim ecosystem restoration goals included. National Park Service scientists and managers assisted policy makers in evaluating these controversial issues and will continue to work toward accomplishing restoration goals consistent with the mission of protecting national park resources. ■

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Wind Cave restoration guided by balancing cultural and natural resource preservation

By Rodney D. Horrocks and Marc J. Ohms

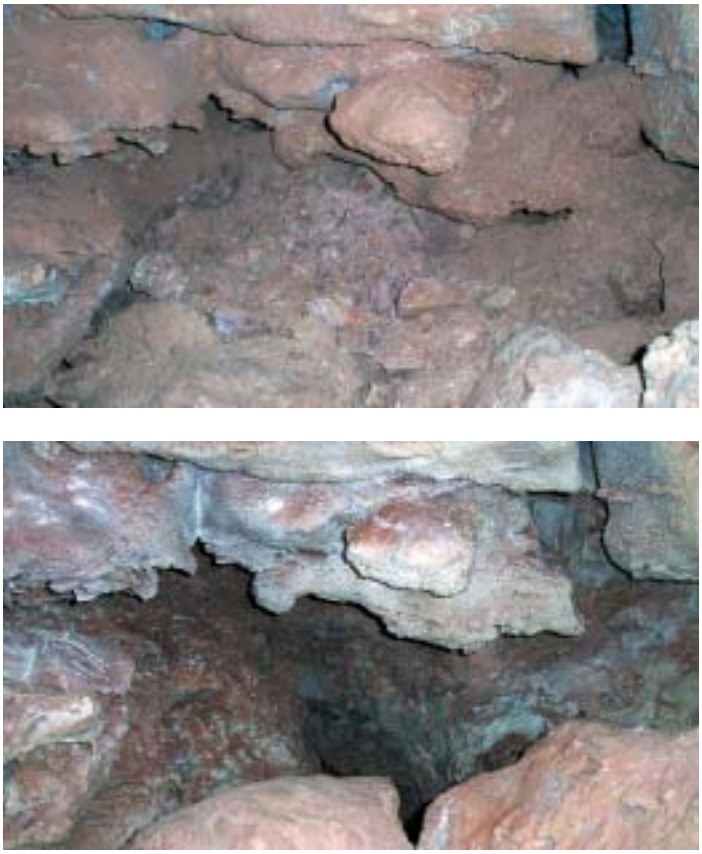
IN THE 1890S, when early developers of Wind Cave, South Dakota, blasted narrow passages to create public tour routes, they were making history. They were also altering the cave's fragile natural conditions. Many resource managers in the National Park Service are acrobats in the balancing act of cultural vs. natural resources, but this is the first time this act has been performed with the help of a cultural landscape survey in an NPS-administered cave. A project to restore the Natural Entrance Tour Route in Wind Cave was funded in FY 2003 through the Natural Resource Preservation Program and led to the detailed survey.

In November 2002, a team of historical building and landscape architects pioneered new ground as they evaluated cultural cave resources along the Natural Entrance Tour Route. Until that time the National Park Service had never completed a cultural landscape survey in a cave, so no previous work in a similar setting could guide the team. As they explored "new territory," the team identified cultural resources such as trails, handrails, stairs, retaining walls, artifacts (e.g., 25¢ cave tickets, flash-powder bottles, Lucky Strike cigarette packs, and wine bottles), signatures etched on cave walls, blast holes, and trail-construction debris. Although much of the debris would be removed to restore the cave's natural conditions, the cultural landscape survey team made preliminary recommendations that called for intentionally placed rocks lining the trail, or for leaving particular deposits that were not blocking cave passages in place.

In addition to early developers, the Civilian Conservation Corps further modified tour routes in the 1930s and park staff paved trails with asphalt in 1956. These projects amassed a tremendous amount of debris, including blast rock, gravel, sand, displaced sediment, asphalt, concrete, and wood. Workers dumped most of this construction debris in side passages, altering the natural environment. They also used it to level walkways. More subtle human impacts include dust, lint, hair, and skin flakes shed from 90,000 annual visitors, and dust from development, which has built up on all cave surfaces. This material dissolves and hides the true colors of cave formations and provides unnatural food sources for cave biota.

In preparation for this project, staff mapped and digitized the locations of artificial-fill deposits along three developed tour routes within the cave. They photographed each deposit for later comparison with the restored sites. Preparation work also involved compliance with the National Environmental Policy Act (NEPA) and Section 106 of the National Historic Preservation Act, including consultation with 19 Native American tribes with cultural affiliations with the park. In addition, a representative of the State Historic Preservation Office visited the cave to discuss how to manage any cultural artifacts found during the project.

The team of seven seasonal laborers did not restore as much of the trail as originally planned. Seasonal staff found artificial-fill deposits to be much deeper than expected; many of these deposits were more than 5 feet (1.5 m) deep and contained tons of debris, which had to be manually hauled out of the cave. Nevertheless, by the end of the six-month project, staff had restored 750 feet (229 m) of the tour route and removed 36 tons of debris from the cave, resulting in a dramatic improvement of the natural cave environment.



An arduous restoration project at Wind Cave transformed Lena's Cave (pictured) and other features along three developed tour routes from a debris-covered depression (top) to a natural-functioning and -looking cave passageway (bottom). Park staff removed 36 tons of blast rock, gravel, sand, and other materials that were deposited when the access trails were constructed, revealing rich cave detail and color.

This project was the first phase of a multiyear project to mitigate impacts of development and more than 100 years of touring. The cultural landscape survey was integral to protecting and preserving both natural and cultural resources in the cave. Using what was learned during this initial phase, park staff is confident that future projects will complete the restoration of the remaining paved tour routes in Wind Cave. ■

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Hurricane Isabel: A case study in restoration response at three Mid-Atlantic national seashores

By Rebecca Beavers and Julia Brunner

HURRICANE ISABEL made landfall at Cape Lookout National Seashore along the North Carolina coast on September 18, 2003. The powerful northeast quadrant of the storm also struck Cape Hatteras National Seashore, opening a 1,700-foot-wide breach in the narrow barrier island park. Additionally, storm waves washed over the lower portions of Assateague Island National Seashore in Maryland and Virginia, piling sand on parking lots and roads. Although these three barrier island parks were affected by the storm, Cape Hatteras faced the greatest restoration effort. The only road to give island residents access to their homes within this national seashore was damaged and required immediate attention. The need to restore public access influenced the park's decisions related to natural resource management.

Hurricanes and other storms are vital for maintaining the barrier islands along the Atlantic Coast. Storm waves wash over the islands, depositing sand that stretches across the islands in fanlike shapes and adds elevation. As the beach on the ocean side erodes, the corresponding buildup of sand toward the more protected sound side preserves the island by allowing it to remain above rising sea level. If this process did not occur, barrier islands would break apart very quickly and be inundated.

At Cape Lookout and Assateague Island National Seashores the National Park Service is able to maintain natural barrier island processes because infrastructure such as roads and homes is minimal. The fans of sand resulting from Hurricane Isabel are being preserved for detailed geologic study and are playing out their natural role of island preservation. Indeed, at Assateague, a prestorm shoreline restoration project to mitigate the impacts of jetties constructed at Ocean City (see page 75) was designed to allow the natural storm process to continue. Nevertheless, the National Park Service facilitates visitor use at these national seashores. Cape Lookout is repairing the docks to restore boat access to the barrier island. Additionally, the interdunal sand road—a transitory, unpaved driving route—has been relocated and meanders across the new sand deposits. On the south end of Assateague Island, portable visitor-use facilities that were demobilized in preparation for the storm are being reinstalled on the new sand deposits. At these national seashores, requests for NPS protection of private and state infrastructure are minimal.

"The presence of six villages within the park results in private and state 'restoration' actions that alter many of the park's natural resources, including barrier island dynamics."

The situation at Cape Hatteras, however, is quite different. The State of North Carolina has the right to maintain State Highway 12 running through the park. Moreover, the presence of six villages within the park results in private and state "restoration" actions that alter many of the park's natural resources, including barrier island dynamics. The breach or inlet opened by Hurricane Isabel severed Highway 12 northeast of Hatteras Village, cutting off residents from

A 1,700-foot passage between the Atlantic Ocean and Pamlico Sound at Cape Hatteras National Seashore, North Carolina, was created on September 18, 2003, when 25-foot waves and a storm surge caused by Hurricane Isabel slammed into the Outer Banks. The breach was subsequently filled and the road reconstructed within two months of the storm.

South of Cape Hatteras, Cape Lookout National Seashore has no permanent road. Sediments that washed over the park have been preserved as geologic features for visitors to explore and contemplate.

their prestorm mode of travel along asphalt roads. The situation was considered an emergency because no other means of access, such as bridge, causeway, or ferry, is available to the village. Accordingly, the U.S. Department of Homeland Security directed the Army Corps of Engineers to fill the new inlet. Once the inlet was filled, the state transportation department reconstructed the broken segment of highway.

Private property owners in the park also tried to restore prestorm conditions by reconstructing berms between their homes and the park beach, using the 2–4 feet (0.6–1.2 m) of sand that had washed onto their property. Unlike the case at many barrier islands, large berms are not natural to Cape Hatteras. In an effort to maintain barrier island dynamics on parklands, the park did not allow residents to use park beaches as a sand source for the berms, and required the berms to be built as far onto private property as possible.

The sheer magnitude of Hurricane Isabel's effects on the infrastructure along the barrier islands has heightened the awareness of state agencies and local communities of the need for environmentally sound, long-term transportation planning. Cape Hatteras National Seashore has long been involved with the Outer Banks Task Force, an interagency panel that has studied Highway 12 problems for 10 years. Spurred by the storm, the panel is finalizing its recommendations to guide the interagency response to any future inlets created by storms on the Outer Banks. If the results of these collaborative planning efforts can be implemented after future storms, community restoration actions may become more consistent with natural coastal processes. ■

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NPS**FACT**

In 2000 the National Park Service set a five-year goal under the Government Performance and Results Act (GPRA goal Ia1A) to restore **10.1% of 222,300 acres (90,032 ha), or 22,500 acres (9,113 ha)** of parklands disturbed by development or agriculture.* The Park Service is on course to meet the FY 2005 target date, with cumulative totals of **4,716 acres (1,190 ha)** restored as of **FY 2001, 8,656 acres** (3,469 ha) as of FY 2002, and 13,525 acres (5,478 ha) or 60% of the goal as of FY 2003.

**The goal is specific to disturbed lands restoration (i.e., disturbed by development or agriculture) and does not address restoration of fauna, control of invasive plants, and use of fire as a restoration tool. Causes of disturbance include facilities, roads, mines, dams, abandoned campgrounds, farming, grazing, timber harvest, and abandoned irrigation ditches. The goal is updated every three years to account for progress and changes in the total area being targeted for restoration.*

Interagency collaboration helps pinpoint Hurricane Isabel impacts

By Rebecca Beavers and Tim Smith

Several agencies collaborated in the aftermath of Hurricane Isabel to assess the storm's impacts on Cape Hatteras and Cape Lookout National Seashores on the North Carolina Outer Banks. Once the storm had made landfall in North Carolina, the National Oceanic and Atmospheric Administration (NOAA) flew the coast and deployed a new research digital aerial-photography system. The tool recorded coordinates associated with 1.2-foot-resolution digital images and aircraft positional and attitude data. In response to the need for rapid assessment of hurricane impacts, the USGS Rocky Mountain Mapping Center is developing a method to process poststorm imagery and make it available to land managers. Their technique uses the aircraft positional and attitude data to ortho-rectify or correct the aerial imagery through a batch process, saving many hours of processing time. The imagery will be made available to the public over the Internet. Users will be able to call up the images in mosaics corresponding to regions of interest.

The USGS Center for Coastal and Watershed Studies and NASA also collected pre- and poststorm EAARL (Experimental Advanced Airborne Research Lidar) data to analyze the impacts of the hurricane. The high level of detail in these topographic and ocean-floor data provides a way to quantify amounts of sediment moved by the storm and understand the geologic impacts in the national seashores. Maps produced for a new inlet area at Cape Hatteras in the days following the storm helped natural resource managers visualize the new shape of the park. ■

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